

(1) More positive than negative electricity is brought down by snow in the proportion of about 3·6 to 1.

(2) Positively charged snow falls more often than negatively charged.

(3) The vertical electric currents during snowstorms are on the average larger than during rainfall.

(4) The charge per unit mass of precipitation is larger during snowfall than during rainfall.

Long-Period Determination of the Rate of Production of Helium from Radium.

By Sir JAMES DEWAR, M.A., Sc.D., LL.D., F.R.S.

(Received January 10,—Read January 27, 1910.)

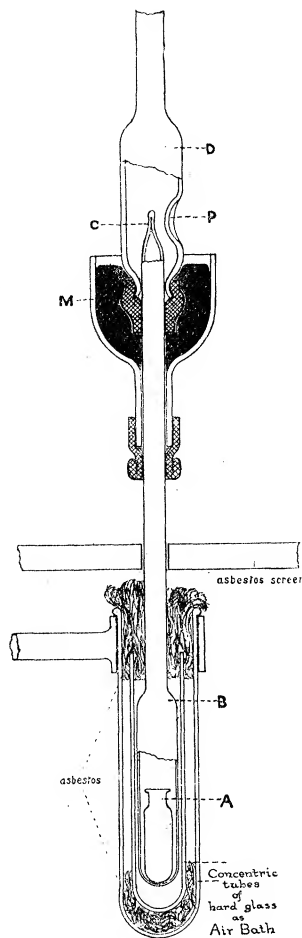
In a previous communication* the rate of the production of helium from 70 milligrammes of radium chloride was determined by a succession of observations on the growth of pressure measured by a McLeod gauge. These observations extended over a period of about six weeks. It was thought desirable to make an experiment to determine the amount of helium resulting from this same sample of radium, after standing in a sealed bulb for an extended period. For this purpose the bulb containing the radium chloride was sealed off at the conclusion of the above-mentioned experiment of 1908 and kept for nine months. In order to measure the helium thus produced it was necessary to devise a vacuum-tight joint between the sealed radium bulb and a McLeod gauge so constructed that, after thoroughly exhausting the gauge, the drawn-out end of the radium bulb could be broken off, thus allowing the pressure of the accumulated helium in the radium bulb to be rapidly determined.

Such a joint is shown in fig. 1. A is the small bottle containing the radium chloride resting in the cylindrical bulb B with long tubular neck drawn out to a capillary, and sealed off at C at the conclusion of the first experiment. This tubular neck slides with slight clearance into the drawn-out neck of another cylindrical bulb D of stout glass, and is attached to it by a short, stout, indiarubber connection protected by a glass mercury cup M, previously fixed as shown on the neck of the radium bulb. This drawn-out neck is so shaped that the radium bulb can be readily rocked in a vertical plane about the neck as pivot within the limits of the diameter of D when so connected.

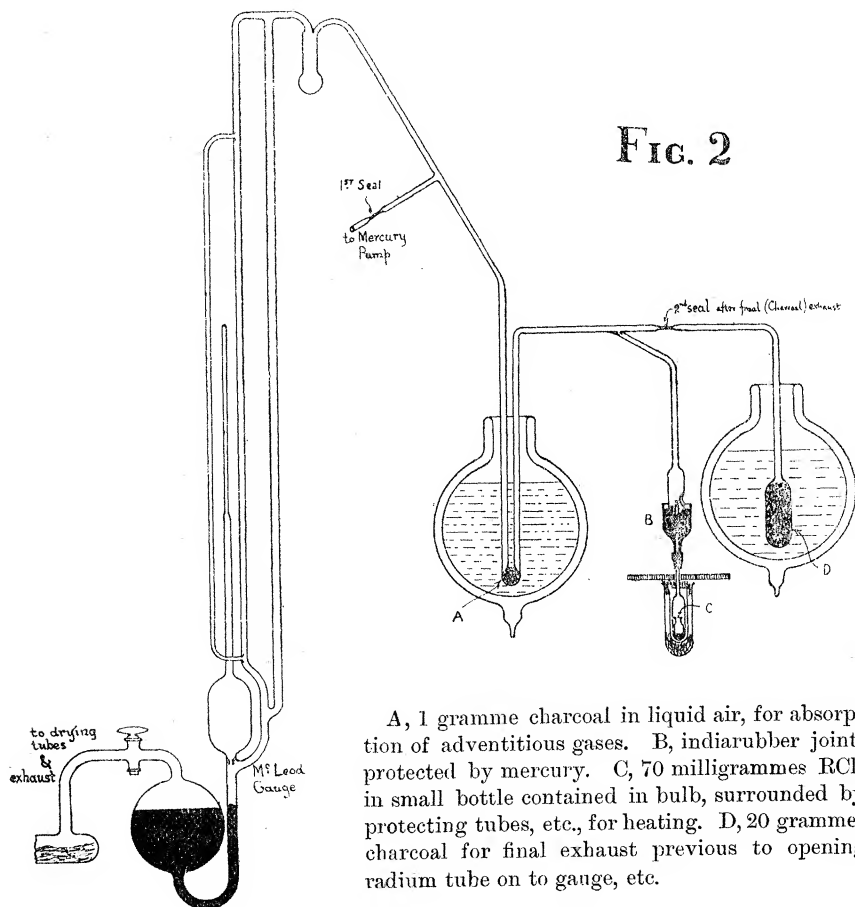
* 'Roy. Soc. Proc.,' A, vol. 81, p. 280, 1908.

A portion of the wall of the stout cylindrical bulb D is drawn in to form an internal projection as shown at P. Before introducing the radium bulb into this joint, a file mark is made in the capillary portion C. The top of D is drawn down and sealed on to the McLeod gauge. This joint was found to be easily workable as regards safely breaking off the sealed-up end of a tube comparable to that containing the radium, and was then thoroughly tested as follows for leakage. The apparatus was first set up as shown in fig. 2, which is the form in which the final observations were made. The gauge was similar to that used in the last experiment, but of larger dimensions. A U-tube containing 1 gramme of cocoanut charcoal (freed from mineral impurity by treatment with chlorine at a high temperature with subsequent removal of the chlorine by hydrogen) was sealed between the gauge and a T-piece: to the arms of the T-piece were sealed (1) a bulb containing 20 grammes of cocoanut charcoal to give a high exhaust in the apparatus; (2) the bulb containing the radium and the vacuum-tight joint. For the purpose of testing the joint, the large exhausting charcoal was not required, and that arm of the T-joint was therefore merely sealed up. Also the radium tube was replaced by a dummy tube of the same size. The apparatus was now exhausted to a low pressure by a mercury pump, and observations made of the amount of leakage. It was found that during a period of 19 days the daily rate of leakage did not exceed 0.0026 mm., and in the succeeding 10 days this fell to 0.0008 mm. per day. If, however, the small charcoal was placed in liquid air, the pressure remained quite constant during a week, demonstrating that the cooled charcoal is quite sufficient to condense all adventitious gases which could possibly appear during the relatively short period required for opening the bulb and measuring the pressure.

The large charcoal bulb was now sealed on and the radium bulb placed in position in the joint, having been well heated 20 hours previously to expel as far as possible any helium which had become occluded in the glass or the

**FIG. 1**

radium salt. The whole apparatus was then exhausted by the mercury pump, while both charcoals were heated to a pressure of about 0.05 mm. The larger charcoal was then placed in liquid air to thoroughly exhaust the apparatus, whereby a pressure of 0.00005 mm. was obtained. The large exhausting charcoal was now sealed off, and the 1-gramme charcoal U-tube placed in liquid air, in which it remained during all the subsequent observations. After one hour the pressure remained at 0.00005.



Now, by cautiously rocking the radium bulb in the neck of D, the capillary end C was pressed against the protuberance at P, and was thus broken off at the file mark, admitting the gases from the radium bulb into the gauge. The pressure obtained in the apparatus now measured 0.01614, which was unaltered on standing for half an hour. On now heating the radium the pressure rose to 0.01626 mm.

The total volume of the apparatus was 320 c.c.; also since the pressure in

the radium bulb when sealed off at the conclusion of first experiment was 0.00406 mm., the partial pressure due to this amount of helium would be 0.00008 mm., which must be deducted from the observed pressure to get the true pressure due to the helium produced in the radium bulb during the period in which it remained sealed up. Also the pressure in the gauge, before breaking (0.00005 mm.), must also be deducted. This gives a corrected pressure of 0.01613 mm., obtained after heating the salt, due to the helium produced from 70 milligrammes of pure radium chloride during a period of 275 days, in a space the total volume of which was 320 c.c. We thus deduce the value of the rate in terms of cubic millimetres of helium per gramme of radium per day as 0.463.

The experiment was now continued for some five weeks on the lines of the former determinations, observations of pressure being made daily to observe the rate of production of helium from the radium while thus connected with the gauge and cooled charcoal.

At weekly intervals the radium was heated, and a rise of pressure was recorded. Between the times of heating, the pressure fluctuated somewhat, but in general gave evidence of only rising slightly. Through the "heated" observations, which were six in number, the nearest straight line was drawn, as in the earlier experiments. The calculated increment so obtained, however, had a value as high as 1.26 cubic millimetres of helium per gramme of radium per day. This high value is untenable, and is explained by the action of the radium emanation on the surface of the vaselined rubber joint producing hydrogen which would remain uncondensed by the cooled charcoal. This could probably have been improved by a layer of mercury inside the tube D round the neck C of the radium chloride bulb, which would have prevented the gases in the apparatus coming into direct contact with the rubber.

In the first paper on this subject the increment was given as 0.37 cubic millimetres of helium per gramme of radium per day. This was calculated by taking the volume of the gauge and apparatus to be 200 c.c. It was subsequently discovered that this had been erroneously estimated, and that the correct value was 270 c.c. This would give an increment of 0.499 cubic millimetres which must thus be regarded as the true value obtained from the first series of experiments, in which the action of the emanation on organic material ought to have been far less. Further, inasmuch as the radium was then subjected to weekly heatings, the probability of permanent occlusion of helium in the glass and salt, and consequent lowering of the value of the observed increment, would be less than by leaving the radium in a sealed bulb unheated for long periods. It is, therefore, possible that the value 0.463,

obtained from the long-period observation, may in reality be rather low, and the value 0.499, obtained in the earlier experiments, might be a little high owing to traces of water or organic matter giving some hydrogen along with helium.

Note on Carbon Monosulphide.

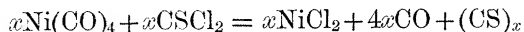
By Sir JAMES DEWAR, M.A., LL.D., Sc.D., F.R.S., Jacksonian Professor in the University of Cambridge, and HUMPHREY OWEN JONES, M.A., D.Sc., Jacksonian Demonstrator in the University of Cambridge.

(Received January 10,—Read January 27; received in revised form February 3, 1910.)

No chemical double decomposition is known which results in the direct production of a substance of the composition of carbon monosulphide. We have discovered such a reaction.

Thiophosgene* reacts rapidly with nickel carbonyl at the ordinary temperature, and less rapidly at -20° C., to produce a brown solid and a large volume of carbon monoxide. Although the reaction is apparently violent the mixture rather falls in temperature just as the similar mixture of nickel carbonyl and oxalyl chloride does.† The solid was found to consist of nickel chloride, which was readily extracted by water, and a brown solid containing carbon and sulphur. The reaction takes place readily between the two liquids or their vapours alone, or between the liquids mixed with dry ether, petroleum ether, carbon tetrachloride, or chloroform, and even when the two substances had been carefully dried by contact with pure phosphorus pentoxide.

It seemed possible that the reaction had taken place according to the equation



to produce a solid polymeric form of carbon monosulphide.

Quantitative experiments gave results in agreement with this view, as may be seen from the following examples.

0.860 gramme CSCl_2 and 1.5 grammes $\text{Ni}(\text{CO})_4$ in dry ether gave 1.21 grammes of solid, of which 0.89 gramme was NiCl_2 and 0.40 gramme solid

* The thiophosgene used was obtained from Schuchardt, and when purified by distillation boiled at 72° — 73° C. under 730 mm. pressure.

† 'Chem. Soc. Trans.,' 1909, vol. 95, p. 1909.